

WHAT IS CLAIMED IS:

1. An apparatus for chemical sensing comprising:

(a) a light source capable of producing a laser light beam having two frequencies which are orthogonal to each other in polarization, said light source positioned to direct said laser light into a waveguide;

5 (b) at least one thin film of host reagent attached to a surface of said waveguide;

(c) a polarizer positioned to receive output of said waveguide;

(d) a photodetector positioned to receive output of said polarizer; and

10 (e) a phase sensitive detector connected to said photodetector so as to receive signals from said polarizer.

2. An apparatus as recited in Claim 1 wherein said light source is a Zeeman laser.

3. An apparatus as recited in Claim 2 wherein said Zeeman laser is a HeNe laser.

4. An apparatus as recited in Claim 1 wherein said light source is a laser

diode positioned to direct a beam of laser light into a polarized beam splitter and modulator.

5. An apparatus as recited in Claim 1 wherein said waveguide is a planar waveguide.

6. An apparatus as recited in Claim 5 wherein said planar waveguide is a ribbed channel waveguide.

7. An apparatus as recited in Claim 5 wherein said waveguide is ribbed with a plurality of channels.

8. An apparatus as recited in Claim 7 wherein said plurality of channels are serpentine channels.

9. An apparatus as recited in Claim 1 wherein said waveguide is comprised of a waveguide material selected from the group of: silicon, silicon nitride, quartz, zinc oxide, zirconium oxide, tin oxide, indium-tin oxide, lithium niobate, gallium arsenide and titanium dioxide.

10. An apparatus as recited in Claim 9 wherein said waveguide material is silicon nitride.
11. An apparatus as recited in Claim 1 wherein said waveguide comprises at least two layers, at least one of which is a waveguide substrate for said at least one layer of waveguide material.
12. An apparatus as recited in Claim 11 wherein said waveguide substrate is comprised of a material selected from the group of silicon dioxide, silicate glass, quartz, gallium arsenide, lithium niobate and oxidized silicon.
13. An apparatus as recited in Claim 12 wherein said waveguide substrate is comprised of silicon oxide.
14. An apparatus as recited in Claim 12 wherein said waveguide substrate is comprised of quartz.
15. An apparatus as recited in Claim 11 wherein said waveguide substrate is supported by a silicon wafer.

16. An apparatus as recited in Claim 1 further comprising a layer of waveguide material coating between said waveguide and said thin film of host reagent.
17. An apparatus as recited in Claim 11 wherein said waveguide material has an index of refraction higher than that of said host reagent and said waveguide substrate material.
18. An apparatus as recited in Claim 1 wherein said at least one layer of said waveguide material is in the range from about 2 nanometers to about 5 microns in thickness.
19. An apparatus as recited in Claim 11 wherein said at least one layer of said waveguide substrate is in the range from about 1 micron to about 3 microns.
20. An apparatus as recited in Claim 9 wherein said at least one layer of said waveguide material has a refractive index in the range from about 1.4 to about 3.5.
21. An apparatus as recited in Claim 11 wherein the index of refraction of said waveguide material differs from the index of refraction of said waveguide substrate by an amount in the range from about 0.01 to about 1.0.

22. An apparatus as recited in Claim 1 wherein said host reagent is a cyclodextrin derivative.

23. An apparatus as recited in Claim 22 wherein said cyclodextrin derivative is one formed from one or more of:  $\alpha$ -cyclodextrin,  $\beta$ -cyclodextrin,  $\gamma$ -cyclodextrin, modified  $\alpha$ -cyclodextrins, modified  $\beta$ -cyclodextrins, modified  $\gamma$ -cyclodextrins and mixtures thereof.

24. An apparatus as recited in Claim 22 wherein said cyclodextrin derivative is a cyclodextrin modified by addition of at least one functional group selected from: a carboxyl group, a carboxyl alkyl group, a carboxylaryl group, an alkyl group, a hydroxyalkyl group, a sulfonic group, or an alkylenesulfonic group and the like and combinations thereof.

25. An apparatus as recited in Claim 23 wherein said cyclodextrin derivative is one selected from the group of peralkylated  $\beta$ -cyclodextrin, peralkylated  $\gamma$ -cyclodextrin, cyclodextrin derivatives containing aryl groups and mixtures thereof.

26. An apparatus as recited in Claim 23 wherein said cyclodextrin derivative

is one selected from the group of peralkylated  $\beta$ -cyclodextrin, peralkylated  $\gamma$ -cyclodextrin, heptakis(2-O-trimethylbenzyl)- $\beta$ -cyclodextrin, octakis(2-O-trimethylbenzyl)- $\gamma$ -cyclodextrin, heptakis(2-O-trimethoxylbenzyl)- $\beta$ -cyclodextrin, octakis(2-O-trimethoxylbenzyl)- $\gamma$ -cyclodextrin and mixtures thereof.

27. An apparatus as recited in Claim 22 wherein at least one layer of said cyclodextrin derivative is covalently attached to said waveguide with a silane linking agent.

28. An apparatus as recited in Claim 1 wherein said host reagent is a calixarene.

29. An apparatus as recited in Claim 28 wherein said calixarene is one selected from the group of p-tert-butyl calix[n]arenes wherein n = a number from 4 to 8, derivatives thereof, and mixtures thereof.

30. An apparatus as recited in Claim 28 wherein said calixarene is one selected from the group of p-aryl-calix[n]arene, p-amino-calix[n]arene, p-alkyl-calix[n]arene and mixtures thereof.

31. An apparatus as recited in Claim 30 wherein said calixarene is one selected from the group of p-aryl-calix[4]arene, p-aryl-calix[6]arene, p-amino-calix[4]arene, p-amino-calix[6]arene, derivatives thereof and mixtures thereof.
32. An apparatus as recited in Claim 1 wherein a plurality of host reagent layers is attached to said waveguide.
33. An apparatus as recited in Claim 32 wherein said plurality of host reagent layers comprises a first layer of cyclodextrin derivative attached to said waveguide and at least one other layer of cyclodextrin derivative attached to said first layer of cyclodextrin derivative.
34. An apparatus as recited in Claim 32 wherein said first layer of cyclodextrin derivative and said at least one other layer of cyclodextrin derivative are different cyclodextrin derivatives.
35. An apparatus as recited in Claim 32 wherein said plurality of host reagent layers comprises a first layer of cyclodextrin derivative attached to said waveguide and at least one other layer of modified cyclodextrin derivative attached to said first layer of cyclodextrin derivative.

36. An apparatus as recited in Claim 1 wherein said host reagent is in a layer from about 2 nanometers to about 1 micron thick.

37. An apparatus as recited in Claim 1 further comprising a layer of waveguide material coating between said waveguide material and said host reagent.

38. An apparatus as recited in Claim 37 wherein said waveguide material coating is silicon oxide.

39. An apparatus as recited in Claim 1 wherein a transmission axis of said polarizer is set at  $45^\circ$  with respect to a polarization axis of said orthogonally polarized modes.

40. An apparatus as recited in Claim 1 wherein said photodetector is a photodiode or photomultiplier.

41. An apparatus as recited in Claim 1 wherein said phase sensitive detector is a lock-in amplifier.

42. An apparatus as recited in Claim 1 further comprising a connection from said light source to said phase sensitive detector to transmit a reference signal.

43. An apparatus as recited in Claim 1 further comprising a PC connected to said phase sensitive detector so as to receive signals from said phase sensitive detector.

44. An apparatus as recited in Claim 43 wherein said PC has loaded therein software to collect and display phase differences between signals from said phase sensitive detector and said reference signal.

45. An apparatus as recited in Claim 7 wherein at least one of said plurality of channels is not coated with said thin film of host reagent.

46. A plurality of apparatuses as recited in Claim 1 operatively connected.

47. A method of sensing chemical species comprising employing the apparatus of Claim 1.

48. A method for sensing chemical species comprising:

(a) propagating two orthogonally polarized modes of laser light

through a waveguide having thereon a layer of host reagent that forms inclusion complexes with said chemical species; and

(b) comparing the phases of each of said modes of laser light after said modes have propagated through said waveguide with the phase of each of said modes prior to propagation through said waveguide.

49. A method as recited in Claim 48 wherein said waveguide is a ribbed channel waveguide.

50. A method as recited in Claim 49 wherein said waveguide is ribbed with a plurality of channels.

51. A method as recited in Claim 50 wherein said plurality of channels are serpentine channels.

52. A method as recited in Claim 48 wherein said waveguide is comprised of a waveguide material selected from the group of: silicon, silicon nitride, quartz, zinc oxide, zirconium oxide, tin oxide, indium-tin oxide, lithium niobate, gallium arsenide and titanium dioxide.

53. A method as recited in Claim 48 wherein said waveguide material is silicon nitride.

54. A method as recited in Claim 48 wherein said waveguide comprises at least two layers, at least one of which is a waveguide substrate for said at least one layer of waveguide material.

55. A method as recited in Claim 54 wherein said waveguide substrate is comprised of a material selected from the group of silicon dioxide, silicate glass, quartz, gallium arsenide, lithium niobate and oxidized silicon.

56. A method as recited in Claim 55 wherein said waveguide substrate is comprised of silicon oxide.

57. A method as recited in Claim 55 wherein said waveguide substrate is comprised of quartz.

58. A method as recited in Claim 48 further comprising a layer of waveguide material coating between said waveguide and said thin film of host reagent.

59. A method as recited in Claim 54 wherein said waveguide material has a high index of refraction and said host reagent and said waveguide substrate material have a low index of refraction.

60. A method as recited in Claim 48 wherein said at least one layer of said waveguide material is in the range from about 2 nanometers to about 5 microns in thickness.

61. A method as recited in Claim 54 wherein said at least one layer of said waveguide substrate is in the range from about 1 micron to about 3 microns.

62. A method as recited in Claim 48 wherein said at least one layer of said waveguide material has a refractive index in the range from about 1.4 to about 3.5.

63. A method as recited in Claim 54 wherein the index of refraction of said waveguide material differs from the index of refraction of said waveguide substrate by an amount in the range from about 0.01 to about 1.0.

64. A method as recited in Claim 48 wherein said host reagent is a cyclodextrin derivative.

65. A method as recited in Claim 64 wherein said cyclodextrin derivative is one formed from one or more of:  $\alpha$ -cyclodextrin,  $\beta$ -cyclodextrin,  $\gamma$ -cyclodextrin, modified  $\alpha$ -cyclodextrins, modified  $\beta$ -cyclodextrins, modified  $\gamma$ -cyclodextrins and mixtures thereof.

66. A method as recited in Claim 64 wherein said cyclodextrin derivative is a cyclodextrin modified by addition of at least one functional group selected from: a carboxyl group, a carboxyl alkyl group, a carboxylaryl group, an alkyl group, a hydroxyalkyl group, a sulfonic group, or an alkylenesulfonic group and the like and combinations thereof.

67. A method as recited in Claim 64 wherein said cyclodextrin derivative is one selected from the group of peralkylated  $\beta$ -cyclodextrin, peralkylated  $\gamma$ -cyclodextrin, cyclodextrin derivatives containing aryl groups and mixtures thereof.

68. A method as recited in Claim 64 wherein said cyclodextrin derivative is one selected from the group of peralkylated  $\beta$ -cyclodextrin, peralkylated  $\gamma$ -cyclodextrin, heptakis(2-O-trimethylbenzyl)- $\beta$ -cyclodextrin, octakis(2-O-trimethylbenzyl)- $\gamma$ -cyclodextrin, heptakis(2-O-trimethoxybenzyl)- $\beta$ -cyclodextrin, octakis(2-O-

trimethoxylbenzyl)- $\gamma$ -cyclodextrin and mixtures thereof.

69. A method as recited in Claim 64 wherein at least one layer of said cyclodextrin derivative is covalently attached to said waveguide with a silane linking agent.

70. A method as recited in Claim 48 wherein said host reagent is a calixarene.

71. A method as recited in Claim 70 wherein said calixarene is one selected from the group of p-tert-butyl calix[n]arenes wherein n = a number from 4 to 8, derivatives thereof, and mixtures thereof.

72. A method as recited in Claim 70 wherein said calixarene is one selected from the group of p-aryl-calix[n]arene, p-amino-calix[n]arene, p-alkyl-calix[n]arene and mixtures thereof.

73. A method as recited in Claim 70 wherein said calixarene is one selected from the group of p-aryl-calix[4]arene, p-aryl-calix[6]arene, p-amino-calix[4]arene, p-amino-calix[6]arene, derivatives thereof and mixtures thereof.

74. A method as recited in Claim 48 wherein a plurality of host reagent layers is attached to said waveguide.

75. A method as recited in Claim 74 wherein said plurality of host reagent layers comprises a first layer of cyclodextrin derivative attached to said waveguide and at least one other layer of cyclodextrin derivative attached to said first layer of cyclodextrin derivative.

76. A method as recited in Claim 74 wherein said first layer of cyclodextrin derivative and said at least one other layer of cyclodextrin derivative are different cyclodextrin derivatives.

77. A method as recited in Claim 74 wherein said plurality of host reagent layers comprises a first layer of cyclodextrin derivative attached to said waveguide and at least one other layer of modified cyclodextrin derivative attached to said first layer of cyclodextrin derivative.

78. A method as recited in Claim 48 wherein said host reagent is in a layer from about 2 nanometers to about 1 micron thick.

79. A method as recited in Claim 48 further comprising a layer of waveguide material coating between said waveguide material and said host reagent.

80. A method as recited in Claim 79 wherein said waveguide material coating is silicon oxide.

81. A method as recited in Claim 48 wherein said chemical species are volatile organics.

82. A method for sensing chemical species comprising:

(a) propagating two modes of laser light through an optical waveguide having thereon a thin film of host reagent;

(b) contacting said thin film of host reagent with a gas to be tested for presence  
5 of selected chemical species;

(b) analyzing said laser light propagated through said optical waveguide for changes in effective refractive index of each of said modes; and

(c) correlating said changes in effective refractive index with changes known  
to be caused by inclusion of said selected chemical species in said host reagent to  
10 determine the presence and quantity of said selected chemical species in inclusion  
complexes in said host reagent.

83. A method as recited in Claim 82 wherein said waveguide is a ribbed channel waveguide.

84. A method as recited in Claim 83 wherein said waveguide is ribbed with a plurality of channels.

85. A method as recited in Claim 84 wherein said plurality of channels are serpentine channels.

86. A method as recited in Claim 82 wherein said waveguide is comprised of a waveguide material selected from the group of: silicon, silicon nitride, quartz, zinc oxide, zirconium oxide, tin oxide, indium-tin oxide, lithium niobate, gallium arsenide and titanium dioxide.

87. A method as recited in Claim 86 wherein said waveguide material is silicon nitride.

88. A method as recited in Claim 82 wherein said waveguide comprises at least two layers, at least one of which is a waveguide substrate for said at least one layer

of waveguide material.

89. A method as recited in Claim 88 wherein said waveguide substrate is comprised of a material selected from the group of silicon dioxide, silicate glass, quartz, gallium arsenide,  $\text{LiNbO}_3$  and oxidized silicon.

90. A method as recited in Claim 89 wherein said waveguide substrate is comprised of silicon oxide.

91. A method as recited in Claim 89 wherein said waveguide substrate is comprised of quartz.

92. A method as recited in Claim 88 wherein said waveguide substrate is supported by a silicon wafer.

93. A method as recited in Claim 82 further comprising a layer of waveguide material coating between said waveguide and said thin film of host reagent.

94. A method as recited in Claim 88 wherein said waveguide material has a high index of refraction and said host reagent and said waveguide substrate material have

a low index of refraction.

95. A method as recited in Claim 82 wherein said at least one layer of said waveguide material is in the range from about 2 nanometers to about 5 microns in thickness.

96. A method as recited in Claim 88 wherein said at least one layer of said waveguide substrate is in the range from about 1 micron to about 3 microns.

97. A method as recited in Claim 82 wherein said at least one layer of said waveguide material has a refractive index in the range from about 1.4 to about 3.5.

98. A method as recited in Claim 88 wherein the index of refraction of said waveguide material differs from the index of refraction of said waveguide substrate by an amount in the range from about 0.01 to about 1.0.

99. A method as recited in Claim 82 wherein said host reagent is a cyclodextrin derivative.

100. A method as recited in Claim 99 wherein said cyclodextrin derivative is

one formed from one or more of:  $\alpha$ -cyclodextrin,  $\beta$ -cyclodextrin,  $\gamma$ -cyclodextrin, modified  $\alpha$ -cyclodextrins, modified  $\beta$ -cyclodextrins, modified  $\gamma$ -cyclodextrins and mixtures thereof.

101. A method as recited in Claim 99 wherein said cyclodextrin derivative is a cyclodextrin modified by addition of at least one functional group selected from: a carboxyl group, a carboxyl alkyl group, a carboxylaryl group, an alkyl group, a hydroxyalkyl group, a sulfonic group, or an alkylenesulfonic group and the like and combinations thereof.

102. A method as recited in Claim 99 wherein said cyclodextrin derivative is one selected from the group of peralkylated  $\beta$ -cyclodextrin, peralkylated  $\gamma$ -cyclodextrin, cyclodextrin derivatives containing aryl groups and mixtures thereof.

103. A method as recited in Claim 99 wherein said cyclodextrin derivative is one selected from the group of peralkylated  $\beta$ -cyclodextrin, peralkylated  $\gamma$ -cyclodextrin, heptakis(2-O-trimethylbenzyl)- $\beta$ -cyclodextrin, octakis(2-O-trimethylbenzyl)- $\gamma$ -cyclodextrin, heptakis(2-O-trimethoxybenzyl)- $\beta$ -cyclodextrin, octakis(2-O-trimethoxybenzyl)- $\gamma$ -cyclodextrin and mixtures thereof.

104. A method as recited in Claim 99 wherein at least one layer of said cyclodextrin derivative is covalently attached to said waveguide with a silane linking agent.

105. A method as recited in Claim 82 wherein said host reagent is a calixarene.

106. A method as recited in Claim 105 wherein said calixarene is one selected from the group of p-tert-butyl calix[n]arenes wherein n = a number from 4 to 8, derivatives thereof, and mixtures thereof.

107. A method as recited in Claim 105 wherein said calixarene is one selected from the group of p-aryl-calix[n]arene, p-amino-calix[n]arene, p-alkyl-calix[n]arene and mixtures thereof.

108. A method as recited in Claim 107 wherein said calixarene is one selected from the group of p-aryl-calix[4]arene, p-aryl-calix[6]arene, p-amino-calix[4]arene, p-amino-calix[6]arene, derivatives thereof and mixtures thereof.

109. A method as recited in Claim 82 wherein a plurality of host reagent layers is attached to said waveguide.

110. A method as recited in Claim 109 wherein said plurality of host reagent layers comprises a first layer of cyclodextrin derivative attached to said waveguide and at least one other layer of cyclodextrin derivative attached to said first layer of cyclodextrin derivative.

111. A method as recited in Claim 109 wherein said first layer of cyclodextrin derivative and said at least one other layer of cyclodextrin derivative are different cyclodextrin derivatives.

112. A method as recited in Claim 109 wherein said plurality of host reagent layers comprises a first layer of cyclodextrin derivative attached to said waveguide and at least one other layer of modified cyclodextrin derivative attached to said first layer of cyclodextrin derivative.

113. A method as recited in Claim 82 wherein said host reagent is in a layer from about 2 nanometers to about 1 micron thick.

114. A method as recited in Claim 82 further comprising a layer of waveguide material coating between said waveguide material and said host reagent.

115. A method as recited in Claim 114 wherein said waveguide material coating is silicon oxide.

116. A method as recited in Claim 82 wherein said chemical species are volatile organics.

117. A method for chemical species comprising:

- (a) propagating two modes of laser light through an optical waveguide which is coated with a thin film of host reagent;
- (b) contacting said thin film of host reagent with a gas to be tested for presence of selected chemical species;
- (c) transmitting a portion of each of said two modes of laser light through a polarizing analyzer;
- (d) detecting the beat frequency of said two modes of light coming from said polarizing analyzer;
- (e) comparing said beat frequency of said two modes of laser light coming from said polarizing analyzer with the beat frequency of a reference signal having a beat frequency equal to the difference in frequency between said two modes of laser light.

118. A method as recited in Claim 117 wherein the phase of said two modes of laser light coming from said polarizing analyzer is compared with the phase of said reference signal.

119. A method as recited in Claim 117 wherein said two modes of laser light are collinear and orthogonally polarized.

120. A method as recited in Claim 117 wherein the transmission axis of said polarizing analyzer is set at  $45^\circ$  with respect to the polarization axis of said two modes of laser light.

121. A method as recited in Claim 117 wherein said waveguide is a ribbed channel waveguide.

122. A method as recited in Claim 121 wherein said waveguide is ribbed with a plurality of channels.

123. A method as recited in Claim 121 wherein said plurality of channels are serpentine channels.

124. A method as recited in Claim 117 wherein said waveguide is comprised of a waveguide material selected from the group of: silicon, silicon nitride, quartz, zinc oxide, zirconium oxide, tin oxide, indium-tin oxide, lithium niobate, gallium arsenide and titanium dioxide.

125. A method as recited in Claim 124 wherein said waveguide material is silicon nitride.

126. A method as recited in Claim 117 wherein said waveguide comprises at least two layers, at least one of which is a waveguide substrate for said at least one layer of waveguide material.

127. A method as recited in Claim 126 wherein said waveguide substrate is comprised of a material selected from the group of silicon dioxide, silicate glass, quartz, gallium arsenide, lithium niobate and oxidized silicon.

128. A method as recited in Claim 126 wherein said waveguide substrate is comprised of silicon oxide.

129. A method as recited in Claim 126 wherein said waveguide substrate is

comprised of quartz.

130. A method as recited in Claim 126 wherein said waveguide substrate is supported by a silicon wafer.

131. A method as recited in Claim 117 further comprising a layer of waveguide material coating between said waveguide and said thin film of host reagent.

132. A method as recited in Claim 126 wherein said waveguide material has a high index of refraction and said host reagent and said waveguide substrate material have a low index of refraction.

133. A method as recited in Claim 117 wherein said at least one layer of said waveguide material is in the range from about 2 nanometers to about 5 microns in thickness.

134. A method as recited in Claim 126 wherein said at least one layer of said waveguide substrate is in the range from about 1 micron to about 3 microns.

135. A method as recited in Claim 117 wherein said at least one layer of said

waveguide material has a refractive index in the range from about 1.4 to about 3.5.

136. A method as recited in Claim 126 wherein the index of refraction of said waveguide material differs from the index of refraction of said waveguide substrate by an amount in the range from about 0.01 to about 1.0.

137. A method as recited in Claim 117 wherein said host reagent is a cyclodextrin derivative.

138. A method as recited in Claim 137 wherein said cyclodextrin derivative is one formed from one or more of:  $\alpha$ -cyclodextrin,  $\beta$ -cyclodextrin,  $\gamma$ -cyclodextrin, modified  $\alpha$ -cyclodextrins, modified  $\beta$ -cyclodextrins, modified  $\gamma$ -cyclodextrins and mixtures thereof.

139. A method as recited in Claim 137 wherein said cyclodextrin derivative is a cyclodextrin modified by addition of at least one functional group selected from: a carboxyl group, a carboxyl alkyl group, a carboxylaryl group, an alkyl group, a hydroxyalkyl group, a sulfonic group, or an alkylenesulfonic group and the like and combinations thereof.

140. A method as recited in Claim 137 wherein said cyclodextrin derivative is one selected from the group of peralkylated  $\beta$ -cyclodextrin, peralkylated  $\gamma$ -cyclodextrin, cyclodextrin derivatives containing aryl groups and mixtures thereof.

141. A method as recited in Claim 137 wherein said cyclodextrin derivative is one selected from the group of peralkylated  $\beta$ -cyclodextrin, peralkylated  $\gamma$ -cyclodextrin, heptakis(2-O-trimethylbenzyl)- $\beta$ -cyclodextrin, octakis(2-O-trimethylbenzyl)- $\gamma$ -cyclodextrin, heptakis(2-O-trimethoxylbenzyl)- $\beta$ -cyclodextrin, octakis(2-O-trimethoxylbenzyl)- $\gamma$ -cyclodextrin and mixtures thereof.

142. A method as recited in Claim 137 wherein at least one layer of said cyclodextrin derivative is covalently attached to said waveguide with a silane linking agent.

143. A method as recited in Claim 117 wherein said host reagent is a calixarene.

144. A method as recited in Claim 143 wherein said calixarene is one selected from the group of p-tert-butyl calix[n]arenes wherein n = a number from 4 to 8, derivatives thereof, and mixtures thereof.

145. A method as recited in Claim 143 wherein said calixarene is one selected from the group of p-aryl-calix[n]arene, p-amino-calix[n]arene, p-alkyl-calix[n]arene and mixtures thereof.

146. A method as recited in Claim 145 wherein said calixarene is one selected from the group of p-aryl-calix[4]arene, p-aryl-calix[6]arene, p-amino-calix[4]arene, p-amino-calix[6]arene, derivatives thereof and mixtures thereof.

147. A method as recited in Claim 117 wherein a plurality of host reagent layers is attached to said waveguide.

148. A method as recited in Claim 147 wherein said plurality of host reagent layers comprises a first layer of cyclodextrin derivative attached to said waveguide and at least one other layer of cyclodextrin derivative attached to said first layer of cyclodextrin derivative.

149. A method as recited in Claim 147 wherein said first layer of cyclodextrin derivative and said at least one other layer of cyclodextrin derivative are different cyclodextrin derivatives.

150. A method as recited in Claim 147 wherein said plurality of host reagent layers comprises a first layer of cyclodextrin derivative attached to said waveguide and at least one other layer of modified cyclodextrin derivative attached to said first layer of cyclodextrin derivative.

151. A method as recited in Claim 117 wherein said host reagent is in a layer from about 50 nanometers to about 10 microns thick.

152. A method as recited in Claim 117 further comprising a layer of waveguide material coating between said waveguide material and said host reagent.

153. A method as recited in Claim 152 wherein said waveguide material coating is one selected from the group of

154. A method as recited in Claim 153 wherein said waveguide material coating is silicon oxide.

155. A method as recited in Claim 117 wherein said chemical species are volatile organics.

156. A method for chemical species comprising:

- (a) propagating two modes of laser light through an optical waveguide having thereon a thin film of host reagent;
- (b) contacting said thin film of host reagent with a gas to be tested for presence  
5 of selected chemical species;
- (c) transmitting a portion of each of said two modes of laser light through a polarizing analyzer;
- (d) detecting the phase of each of said two modes of light coming from said polarizing analyzer;
- 10 (e) comparing said phase of each of said two modes of laser light coming from said polarizing analyzer with the phase of the other of said two modes of laser light coming from said polarizing analyzer.

157. A method as recited in Claim 156 wherein the phase of said two modes of laser light coming from said polarizing analyzer is compared with the phase of said reference signal.

158. A method as recited in Claim 156 wherein said two modes of laser light are collinear and orthogonally polarized.

159. A method as recited in Claim 156 wherein the transmission axis of said

polarizing analyzer is set at 45° with respect to the polarization axis of said two modes of laser light.

160. A method as recited in Claim 156 wherein said waveguide is a ribbed channel waveguide.

161. A method as recited in Claim 160 wherein said waveguide is ribbed with a plurality of channels.

162. A method as recited in Claim 160 wherein said plurality of channels are serpentine channels.

163. A method as recited in Claim 156 wherein said waveguide is comprised of a waveguide material selected from the group of: silicon, silicon nitride, quartz, zinc oxide, zirconium oxide, tin oxide, indium-tin oxide, lithium niobate, gallium arsenide and titanium dioxide.

164. A method as recited in Claim 163 wherein said waveguide material is silicon nitride.

165. A method as recited in Claim 156 wherein said waveguide comprises at least two layers, at least one of which is a waveguide substrate for said at least one layer of waveguide material.

166. A method as recited in Claim 165 wherein said waveguide substrate is comprised of a material selected from the group of silicon dioxide, silicate glass, quartz, gallium arsenide, lithium niobate and oxidized silicon.

167. A method as recited in Claim 165 wherein said waveguide substrate is comprised of silicon oxide.

168. A method as recited in Claim 165 wherein said waveguide substrate is comprised of quartz.

169. A method as recited in Claim 165 wherein said waveguide substrate is supported by a silicon wafer.

170. A method as recited in Claim 156 further comprising a layer of waveguide material coating between said waveguide and said thin film of host reagent.

171. A method as recited in Claim 165 wherein said waveguide material has a high index of refraction and said host reagent and said waveguide substrate material have a low index of refraction.

172. A method as recited in Claim 156 wherein said at least one layer of said waveguide material is in the range from about 2 nanometers to about 5 microns in thickness.

173. A method as recited in Claim 165 wherein said at least one layer of said waveguide substrate is in the range from about 1 micron to about 3 microns.

174. A method as recited in Claim 156 wherein said at least one layer of said waveguide material has a refractive index in the range from about 1.4 to about 3.5.

175. A method as recited in Claim 165 wherein the index of refraction of said waveguide material differs from the index of refraction of said waveguide substrate by an amount in the range from about 0.01 to about 1.0.

176. A method as recited in Claim 156 wherein said host reagent is a cyclodextrin derivative.

177. A method as recited in Claim 176 wherein said cyclodextrin derivative is one formed from one or more of:  $\alpha$ -cyclodextrin,  $\beta$ -cyclodextrin,  $\gamma$ -cyclodextrin, modified  $\alpha$ -cyclodextrins, modified  $\beta$ -cyclodextrins, modified  $\gamma$ -cyclodextrins and mixtures thereof.

178. A method as recited in Claim 176 wherein said cyclodextrin derivative is a cyclodextrin modified by addition of at least one functional group selected from: a carboxyl group, a carboxyl alkyl group, a carboxylaryl group, an alkyl group, a hydroxyalkyl group, a sulfonic group, or an alkylenesulfonic group and the like and combinations thereof.

179. A method as recited in Claim 176 wherein said cyclodextrin derivative is one selected from the group of peralkylated  $\beta$ -cyclodextrin, peralkylated  $\gamma$ -cyclodextrin, cyclodextrin derivatives containing aryl groups and mixtures thereof.

180. A method as recited in Claim 176 wherein said cyclodextrin derivative is one selected from the group of peralkylated  $\beta$ -cyclodextrin, peralkylated  $\gamma$ -cyclodextrin, heptakis(2-O-trimethylbenzyl)- $\beta$ -cyclodextrin, octakis(2-O-trimethylbenzyl)- $\gamma$ -cyclodextrin, heptakis(2-O-trimethoxylbenzyl)- $\beta$ -cyclodextrin, octakis(2-O-

trimethoxybenzyl)- $\gamma$ -cyclodextrin and mixtures thereof.

181. A method as recited in Claim 176 wherein at least one layer of said cyclodextrin derivative is covalently attached to said waveguide with a silane linking agent.

182. A method as recited in Claim 156 wherein said host reagent is a calixarene.

183. A method as recited in Claim 182 wherein said calixarene is one selected from the group of p-tert-butyl calix[n]arenes wherein n = a number from 4 to 8, derivatives thereof, and mixtures thereof.

184. A method as recited in Claim 182 wherein said calixarene is one selected from the group of p-aryl-calix[n]arene, p-amino-calix[n]arene, p-alkyl-calix[n]arene and mixtures thereof.

185. A method as recited in Claim 182 wherein said calixarene is one selected from the group of p-aryl-calix[4]arene, p-aryl-calix[6]arene, p-amino-calix[4]arene, p-amino-calix[6]arene, derivatives thereof and mixtures thereof.

186. A method as recited in Claim 156 wherein a plurality of host reagent layers is attached to said waveguide.

187. A method as recited in Claim 186 wherein said plurality of host reagent layers comprises a first layer of cyclodextrin derivative attached to said waveguide and at least one other layer of cyclodextrin derivative attached to said first layer of cyclodextrin derivative.

188. A method as recited in Claim 186 wherein said first layer of cyclodextrin derivative and said at least one other layer of cyclodextrin derivative are different cyclodextrin derivatives.

189. A method as recited in Claim 186 wherein said plurality of host reagent layers comprises a first layer of cyclodextrin derivative attached to said waveguide and at least one other layer of modified cyclodextrin derivative attached to said first layer of cyclodextrin derivative.

190. A method as recited in Claim 156 wherein said host reagent is in a layer from about 2 nanometers to about 1 micron thick.

191. A method as recited in Claim 156 further comprising a layer of waveguide material coating between said waveguide material and said host reagent.

192. A method as recited in Claim 191 wherein said waveguide material coating is silicon oxide.

193. A method as recited in Claim 156 wherein said chemical species are volatile organics.